CLAIMS

1. A harvesting head (1, 21) mountable on a robotic arm arrangement of the type having a robot end effector mounting flange and a rotation means, the head (1, 21) having a rotatable shaft (2) with two ends (3, 4), one end (3) of the shaft (2) being adaptable for engagement with the rotation means and the other end (4) having a holder (5, 31) fixed thereon for receiving an object to be harvested, the holder (5, 31) including means (6, 36) for releasably fixing the object relative to the holder (5, 31) wherein a load cell (54) is disposed on the harvesting head (1, 21) for measuring the force being applied to the object during harvesting.

2. A harvesting head (1, 21) as claimed in Claim 1, wherein the rotatable shaft (2) extends from the rotation means.

3. A harvesting head (1, 21) as claimed in Claim1 or Claim 2, wherein the load cell (52) is mounted on a part of the harvesting head (1, 21) which is fixed relative to the robotic arm arrangement during harvesting.

4. A harvesting head (1, 21) as claimed in any one of the preceding claims, wherein the holder (5, 31) has a stem (32) having one end formed for mounting the holder (5, 31) on the shaft (2) and the other end has an expandable head (33) extending therefrom for receiving objects to be harvested, the holder (5, 31) having a central cavity (34) extending along the entire length of the holder (5, 31).

5. A harvesting head (1, 21) as claimed in any one of the preceding claims wherein the means (6) for releasably fixing an object relative to the holder (5, 31) comprises a vacuum drum (36, 100) having a substantially solid body (37, 101) with a vacuum chamber (38, 102) enclosed within the body (37, 101) and a cylindrical bore (39, 103) extending through the body (37, 101) via the chamber (38, 102), the cylindrical bore (39,103) being mounted on the shaft (2) which extends therethrough, the shaft (2) also having a bore (40, 104) extending from the end upon which the holder (5, 31) is mounted to a point along the shaft (2) which the vacuum chamber (38, 102) encloses, the vacuum drum (36, 100) having a second bore (41, 107) extending from the vacuum chamber (38, 102) through the body of the vacuum drum (36, 100) and outside the drum, the bore (41, 107) defining an aperture (42, 108) on the external surface of the drum (36, 100) for receiving a vacuum pipe.

6. A harvesting head (1, 21) as claimed in Claim 5, wherein the vacuum drum (36, 100) is stationary during rotation of the shaft (2) .

7. A harvesting head (1, 21) as claimed in any one of Claims 2 to 6, wherein the rotation means is a motor.

8. A harvesting head (21) mountable on a robotic arm arrangement of the type having a robot end effector mounting flange wherein the harvesting head (21) comprises a first rotatable shaft (22) extending from a rotation means, a second rotatable shaft (24) parallel with and offset laterally from the first rotatable shaft (22) and a mounting means for fixing the shafts (22, 24) relative to one another,

the shafts (22, 24) being coupled by a coupling means, the second shaft (24) having a holder (31) fixed on one end thereof, the holder (31) including means for releasably fixing an object relative to the holder, wherein a load cell (52) is disposed on the head (21) for measuring the force being applied to the object during harvesting.

9. A harvesting head (21) as claimed in Claim 8, wherein the coupling means comprises a belt which winds around a drive wheel (28) on the first shaft (22) and a drive belt guide (27) on the second shaft (24).

10. A harvesting head (21) as claimed in Claim 8 or Claim 9, wherein the mounting means is provided by a support plate (45).

11. A harvesting head (21) as claimed in any one of Claims 8 to 10, wherein the rotation means is a motor (23).

12. A harvesting head (21) as claimed in Claim 10 or Claim 11, wherein the support plate (45) has an aperture (47) and the first rotatable shaft (22) extends through the aperture (47) in the plate (45), engaging the drive wheel (28) on the other side of the support plate (45).

13. A harvesting head (21) as claimed in any one of Claims 9 to 12, wherein the drive belt guide (27) is rotatably mounted on a guide bolt (51) which is in turn mounted on the support plate (45) on the same side of the plate (45) as the drive wheel (28).

14. A harvesting head (21) as claimed in Claim 13, wherein the load cell (52) is mounted on the guide bolt (51).

15. A robotic harvesting system comprising a harvesting head (1, 21) having a load cell (52), the system having a movement control device for delivering the harvesting head (1) onto an object to be picked out of a growing bed, the system also having a controller (84) in communication with the load cell (52) which controls a picking cycle in response to values received from the load cell (52).

16. A robotic harvesting system as claimed in claim 15, comprising a harvesting head (1, 21) as claimed in any one of the claims 1 to 7 or any one of the claims 8 to 14 mounted on a robotic arm arrangement of the type having a robot end effector mounting flange.

17. A robotic harvesting system as claimed in Claim 15 or Claim 16, wherein the controller (84) is also in communication with a rotation means and a means for releasably fixing the object relative to the holder (5, 31) of the harvesting head.

18. A robotic harvesting system as claimed in Claim 17, wherein the operation of the rotation means, the means for releasably fixing the object relative to the holder (5, 31) and the robotic arm arrangement movement control device during the picking cycle are controlled by values of force received from the load cell (52) in combination with a control program running on the controller (84).

19. A method of harvesting objects such as mushrooms comprising the steps of:- identifying a mushroom to be harvested and delivering a harvesting head (1, 21) having a load cell (52) onto the mushroom which is to be picked out of a bed;controlling the harvesting head (1, 21) to pick the mushroom via a control program executing in response to force values received from the load cell (52).

20. A method of harvesting objects such as mushrooms as claimed in Claim 19 comprising the steps of:-

identifying a mushroom to be harvested and locating a holder (5, 31) adjacent the selected mushroom using a robotic arm arrangement's vision system and movement control device;

moving a robotic arm arrangement and holder (5, 31) downwards pressing the mushroom into the soil;

monitoring downward force, which is applied to the mushroom by the robotic arm arrangement via the load cell (52) and control program;

in response to the measured force value reaching a maximum value once or a minimum value twice in the one downward movement, these values being stored as tolerance bands in the control program of the controller, the controller simultaneously generating and transmitting a signal to the rotation means, the robotic arm arrangement's movement control device and the fixing means thereby

(1) stopping the downward motion of the robotic arm arrangement;

(2) activating a means for releasably fixing the mushroom relative to the holder; and

(3) rotating the holder (5, 31) to break all roots holding the mushroom in the ground; after a predetermined period of time the controller generating a signal and transmitting the signal to the rotation means to switch off the rotation means; the controller generating and transmitting a signal to the robotic arm arrangement's movement control device to move the head to a predetermined position; and the controller generating and transmitting a signal to the means for releasably fixing the mushroom relative to the holder (5, 31) turning off the fixing means whereby the mushroom drops into a receptacle.